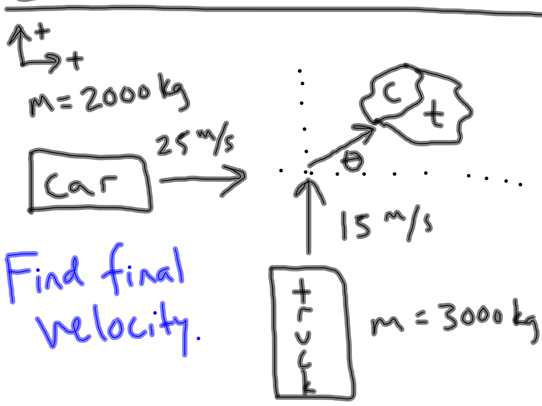
2D Inelastic Collision Notes and Practice Problems 2.13.12 CP Physics

2D Inelastic Problem:



Find final velocity.

x-direction:

$$\overline{P}_{ix} = \overline{P}_{fx}$$

$$\overline{P}_{cix} + \cancel{\overline{P}_{tix}}^{\,0} = \overline{P}_{fx}$$

$$\overline{P}_{fx} = \overline{P}_{cix} = m_c \overline{v}_{cix}$$

$$= (2000\text{ kg})(25\text{ m/s})$$

$$= 50\,000\text{ kg}\cdot\text{m/s}$$

y-direction:

$$\overline{P}_{iy} = \overline{P}_{fy}$$

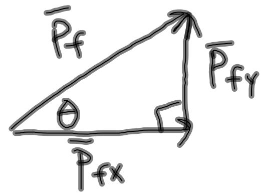
$$\cancel{\overline{P}_{ciy}}^{\,0} + \overline{P}_{tiy} = \overline{P}_{fy}$$

$$\overline{P}_{fy} = \overline{P}_{tiy} = m_t \overline{v}_{tiy}$$

$$= (3000\text{ kg})(15\text{ m/s})$$

$$= 45\,000\text{ kg}\cdot\text{m/s}$$

Find $\bar{P}_f$:



Pythagorean thm. to find P_f

$$P_f^2 = P_{fx}^2 + P_{fy}^2$$

$$P_f = 67268 \text{ kg·m/s}$$

$$\tan\theta = \frac{P_{fy}}{P_{fx}}$$

$$\theta = \tan^{-1}\left(\frac{P_{fy}}{P_{fx}}\right)$$

$$= 42°$$

$$\bar{P}_f = 67268 \text{ kg·m/s @ } 42° \text{ N of E}$$

$$\bar{P}_f = m_{total}\,\bar{V}_f$$

these have the same direction

$$V_f = \frac{P_f}{(m_c + m_t)}$$

$$= \frac{67268 \text{ kg·m/s}}{2000 \text{ kg} + 3000 \text{ kg}}$$

$$= 13.45 \text{ m/s}$$

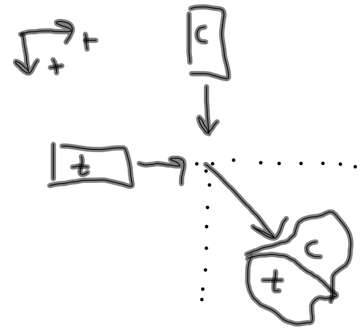
$$\bar{V}_f = 13.45 \text{ m/s @ } 42° \text{ N of E}$$

Steps:

1. Find $\bar{p}_{fx}$.
2. Find $\bar{p}_{fy}$.
3. Make a p_f triangle.
4. To find v_f, divide p_f by combined mass.

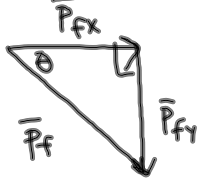
(Angle and direction of $\bar{p}_f$ is the same as $\bar{v}_f$.)

Car with mass = 2300 kg is traveling South at 42 m/s. A truck with mass = 4600 kg is traveling east at 21 m/s. If they collide and stick together, what is their final velocity? (Give magnitude, angle, and direction)



$$\bar{P}_{fx} = \bar{P}_{ix} = \cancel{\bar{P}_{cix}}^{\,0} + \bar{P}_{tix}$$
$$= M_t \bar{V}_{tix}$$
$$= 96600 \text{ kg·m/s}$$

$$\bar{P}_{fy} = \bar{P}_{iy} = \bar{P}_{ciy} + \cancel{\bar{P}_{tiy}}^{\,0}$$
$$= M_c \bar{V}_{ciy}$$
$$= 96600 \text{ kg·m/s}$$

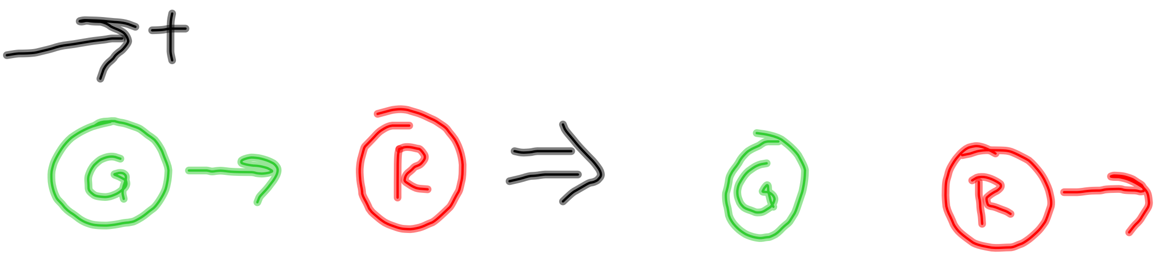


$\theta = 45°$
S of E

$$P_f^2 = P_{fx}^2 + P_{fy}^2$$
$$P_f = 136613 \text{ kg·m/s}$$
$$V_f = \frac{P_f}{(M_c + M_t)} = 19.8 \text{ m/s}$$

$$\boxed{\bar{V}_f = 19.8 \text{ m/s @ } 45° \text{ S of E}}$$

Green ball ($m_G = 4$ kg) moving to the right at 20 m/s. Stationary red ball ($m_R = 10$ kg) is hit with green ball, and the collide elastically. If the red ball has a final velocity of 4 m/s to the right, what is the green ball's final velocity?



$$\bar{P}_{Gi} + \cancelto{0}{\bar{P}_{Ri}} = \bar{P}_{Gf} + \bar{P}_{Rf}$$

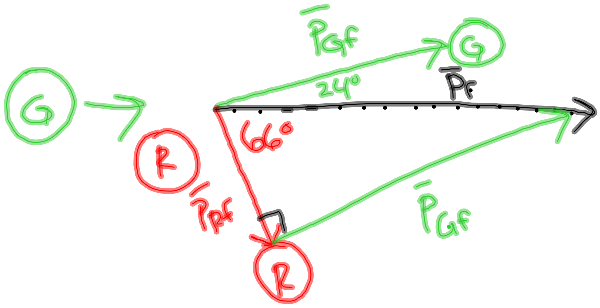
$$m_G\bar{V}_{Gi} + \cancelto{0}{m_R\bar{V}_{Ri}} = m_G\underline{\bar{V}_{Gf}} + m_R\bar{V}_{Rf}$$

$$V_{Gf} = \frac{1}{m_G}\left[m_G\bar{V}_{Gi} - m_R\bar{V}_{Rf}\right]$$

$$= \frac{1}{(4\,\text{kg})}\left[(4\,\text{kg})(20\,\text{m/s}) - (10\,\text{kg})(4\,\text{m/s})\right]$$

$$= 10\,\text{m/s}$$

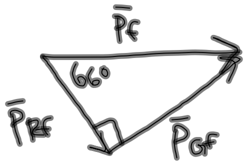
Green ball has $m_G = 10$ kg and is moving at 14 m/s. Red ball ($m_R = 20$ kg) is stationary, and they collide elastically. The green ball goes off at an angle of 24° N of E, and the red ball goes at an angle of 66° S of E. Find the final velocity of the green and red.



$$\bar{P}_i = \bar{P}_f$$

$$\bar{P}_f = \bar{P}_{Gi} + \cancel{\bar{P}_{Ri}}^{\,0} = m_G \bar{V}_{Gi}$$

$$= 140 \text{ kg}\cdot\text{m/s}$$



$$\cos(66°) = \frac{P_{Rf}}{P_f} \qquad \sin(66°) = \frac{P_{Gf}}{P_f}$$

$$P_{Rf} = 56.94 \text{ kg}\cdot\text{m/s} \qquad P_{Gf} = 127.9 \text{ kg}\cdot\text{m/s}$$

$$V_{Rf} = \frac{P_{Rf}}{m_R} \qquad V_{Gf} = \frac{P_{Gf}}{m_G}$$

$$= 2.85 \text{ m/s} \qquad = 12.79 \text{ m/s}$$